OCR
Oxford Cambridge and RSA

An OCR endorsed teaching and learning tool

OCR A Level Computer Science

H446 – Paper 1

1

Logic gates and truth tables

Unit 8

Boolean Algebra

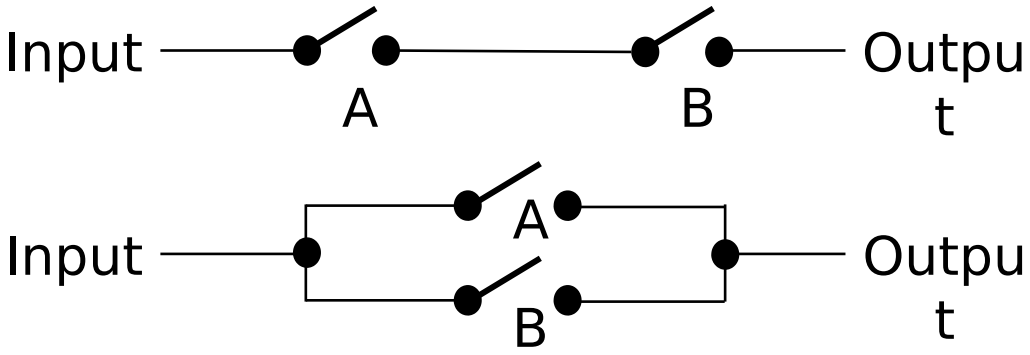
PG ONLINE

Objectives

- Construct truth tables for a variety of logic gates
- Be familiar with drawing and interpreting logic gate circuit diagrams involving multiple gates
- Complete a truth table for a given logic gate circuit
- Write a Boolean expression for a given logic gate circuit
- Draw an equivalent logic gate circuit for a given Boolean expression

Binary switches

- Electronic devices can only recognise the presence or absence of a current
- Computers comprise billions of switches which can either be ON or OFF
- These switches can be combined in different ways to create simple circuits called logic gates



Logic gates

- Electronic logic gates take one or more inputs and produce a single output
- The output can then become the input to the next gate, and so on, to create a complex circuit
  - A number of logic gates are designed to produce different outputs for the various possible combinations of ON or OFF inputs

Logic gates

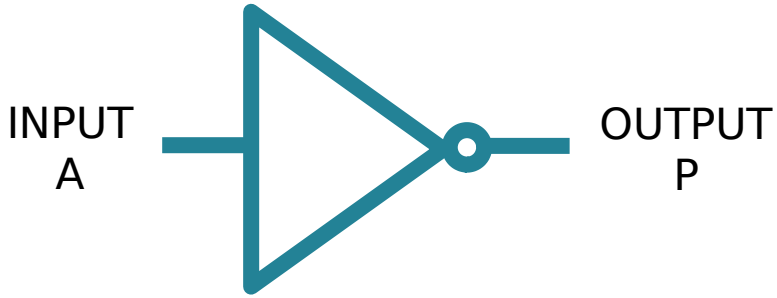
- The four gates studied in this unit are:

  NOT, AND, OR, XOR

- Each of these can be represented by a graphical symbol and a truth table showing the output for each possible input or combination of inputs

NOT gate

- If 0 is input it outputs 1
- If 1 is input it outputs 0



Logic Diagram

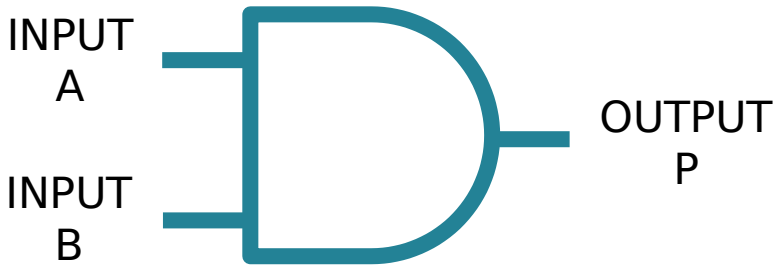
A	P
0	1
1	0

Truth Table

Boolean algebra: P = NOT A **In Boolean notation: P = ¬A**

AND gate

- If both inputs are 1 then the output is 1
- Otherwise the output is 0



Logic Diagram

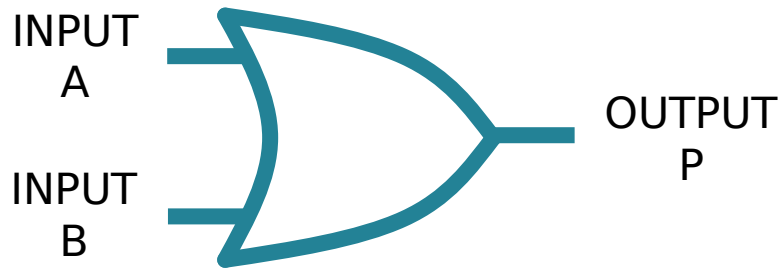
A	B	P
0	0	0
0	1	0
1	0	0
1	1	1

Truth Table

Boolean algebra: P = A AND B **In Boolean notation: P = A ^ B**

OR gate

- If either input is 1 then the output is 1
- Otherwise the output is 0



Logic Diagram

A	B	P
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table

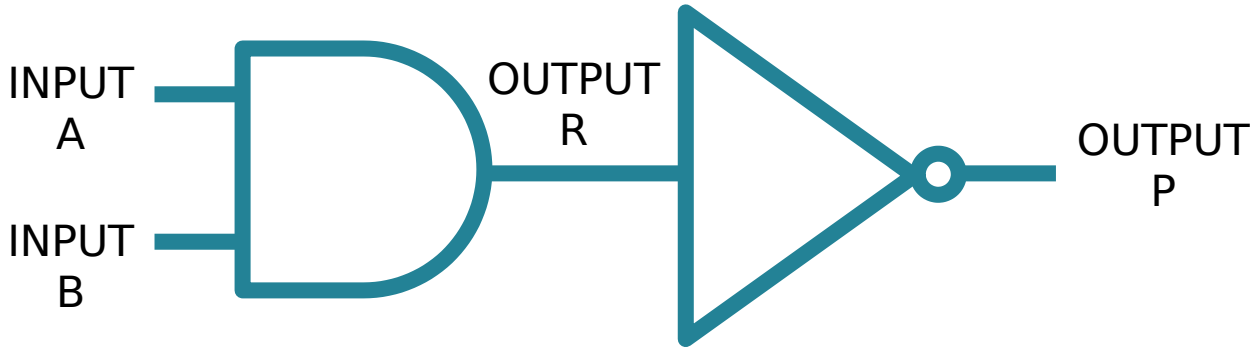
Boolean algebra: P = A OR B In Boolean notation: P = A $^{\vee}$ B

˅ or ˄ … which is which?

- Just remember the common notation for two alternatives, a vs. b or just a v b
- Make up some sentences…
  - What are the merits of Economics v English A Level?
  - Advantages of man v machine?
  - Summer v Winter?

Creating logic circuits

- Multiple logic gates can be connected to produce an output based on multiple inputs



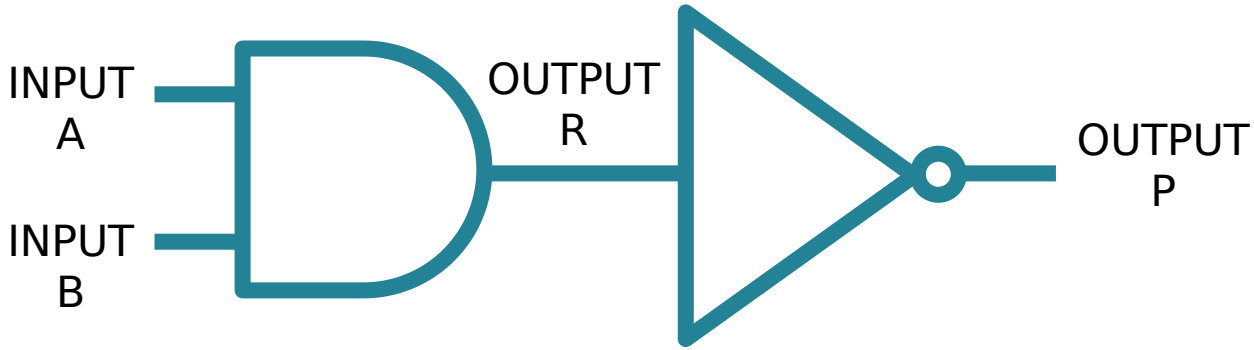
A	B	R = A AND B	P = NOT R
0	0		
0	1		
1	0		
1	1		

Boolean algebra:
P = NOT (A AND B)

In Boolean notation:
P = ¬(A ^ B)

Creating logic circuits

- Multiple logic gates can be connected to produce an output based on multiple inputs



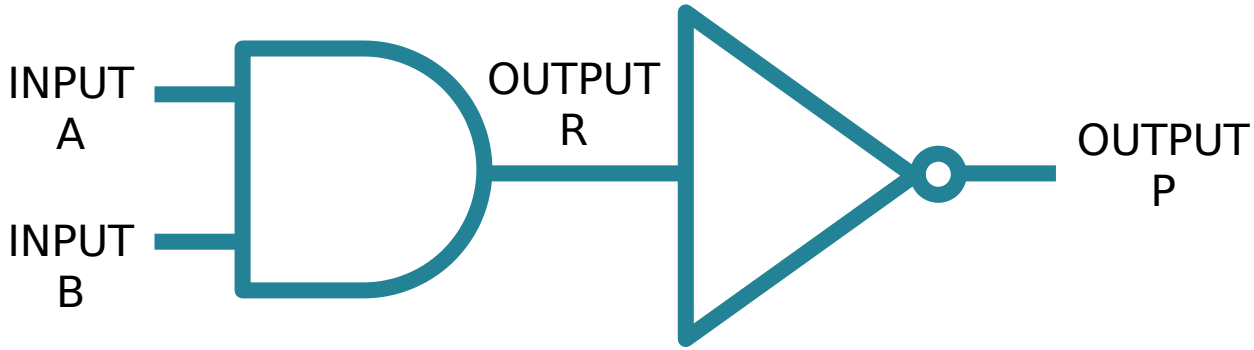
A	B	R = A AND B	P = NOT R
0	0	**0**	
0	1	**0**	
1	0	**0**	
1	1	**1**	

Boolean algebra:
P = NOT (A AND B)

In Boolean notation:
P = ¬(A ^ B)

Creating logic circuits

- Multiple logic gates can be connected to produce an output based on multiple inputs



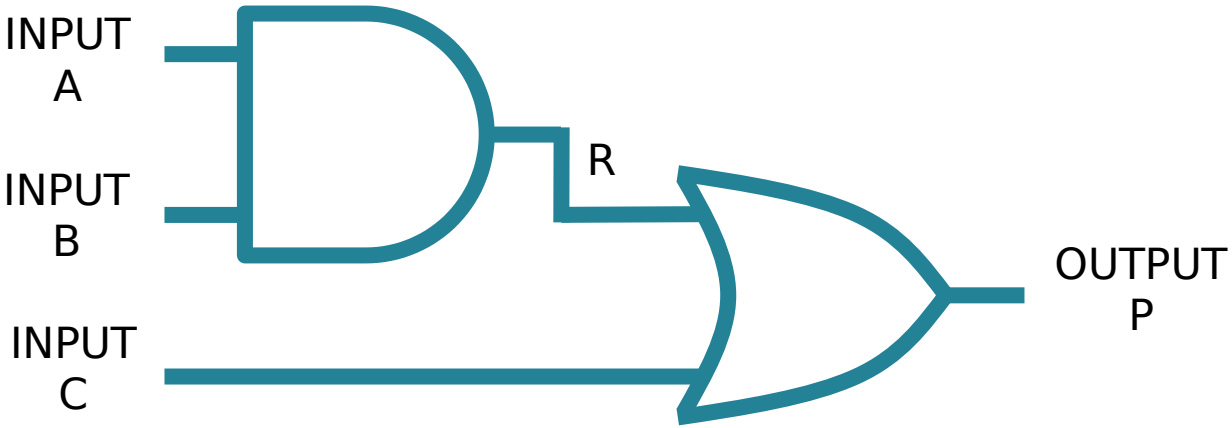
A	B	R = A AND B	P = NOT R
0	0	**0**	**1**
0	1	**0**	**1**
1	0	**0**	**1**
1	1	**1**	**0**

Boolean algebra:
P = NOT (A AND B)

In Boolean notation:
P = ¬(A ^ B)

Increasing the number of inputs

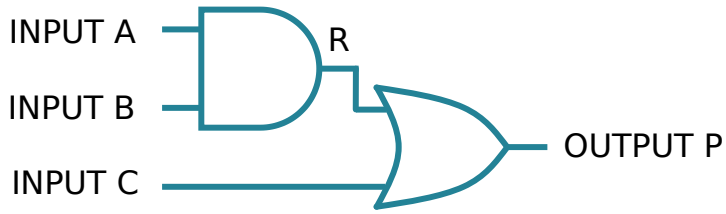
- With three inputs, how many possible combinations of 0 and 1 are there?



Boolean algebra:
P = (A AND B) OR C

In Boolean notation:
P = (A ^ B) ˅ C

Combining logic gates

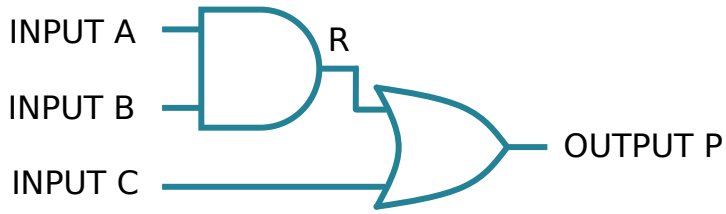


A	B	C	R = A AND B	P = R OR C
0	0	0		
0				
0				
0				
1				
1				
1				
1				

Boolean algebra:
P = (A AND B) OR C

In Boolean notation:
P = (A ^ B) ˅ C

Combining logic gates

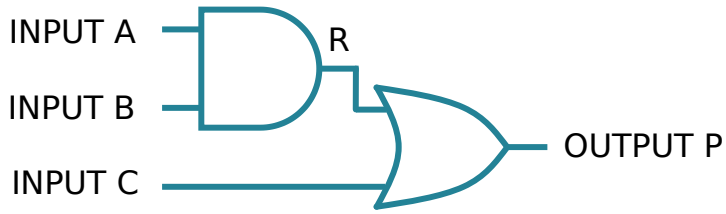


A	B	C	R = A AND B	P = R OR C
0	0	0		
0	0			
0	1			
0	1			
1	0			
1	0			
1	1			
1	1			

Boolean algebra:
P = (A AND B) OR C

In Boolean notation:
P = (A ^ B) ˅ C

Combining logic gates

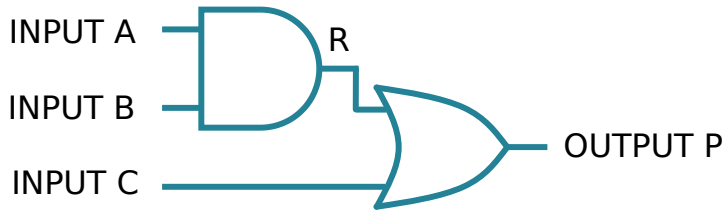


A	B	C	R = A AND B	P = R OR C
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

Boolean algebra:
P = (A AND B) OR C

In Boolean notation:
P = (A ^ B) ˅ C

Combining logic gates

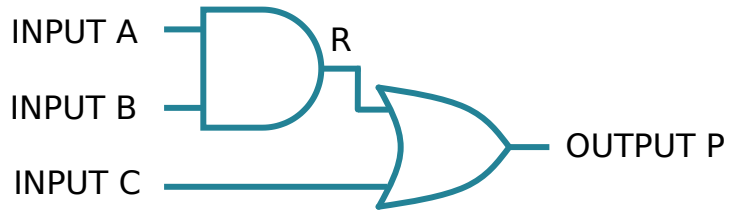


A	B	C	R = A AND B	P = R OR C
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	0	
1	0	0	0	
1	0	1	0	
1	1	0	1	
1	1	1	1	

Boolean algebra:
P = (A AND B) OR C

In Boolean notation:
P = (A ^ B) ˅ C

Combining logic gates



A	B	C	R = A AND B	P = R OR C
0	0	0	0	0
0	0	1	0	1
0	1	0	0	0
0	1	1	0	1
1	0	0	0	0
1	0	1	0	1
1	1	0	1	1
1	1	1	1	1

Boolean algebra:
P = (A AND B) OR C

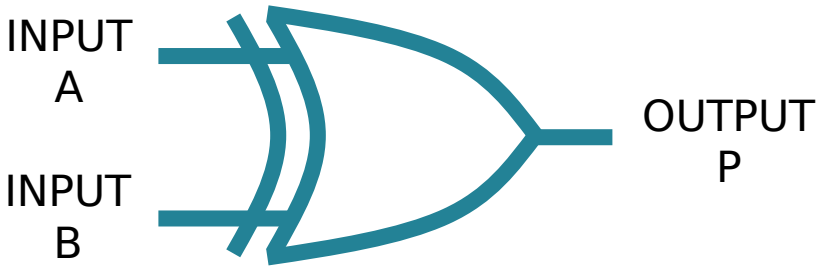
In Boolean notation:
P = (A ^ B) ˅ C

Worksheet 1

- Now try the questions in **Task 1**

XOR (Exclusive OR) gate

- If one, but not both, of the inputs is 1, the output is 1
- Otherwise the output is 0



Logic Diagram

A	B	P
0	0	0
0	1	1
1	0	1
1	1	0

Truth Table

Boolean algebra: P = A XOR B **Boolean notation: P = A ⊻ B**

Worksheet 1

- Now try the questions in **Task 2**

Plenary

- There are four logic gates that you need to be familiar with
- Be sure you can :
  - Write truth tables for each of them
  - Write a Boolean expression for a given logic gate circuit
  - Draw an equivalent logic gate circuit for a given Boolean expression

Copyright

© 2016 PG Online Limited

The contents of this unit are protected by copyright.

This unit and all the worksheets, PowerPoint presentations, teaching guides and other associated files distributed with it are supplied to you by PG Online Limited under licence and may be used and copied by you only in accordance with the terms of the licence. Except as expressly permitted by the licence, no part of the materials distributed with this unit may be used, reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic or otherwise, without the prior written permission of PG Online Limited.

Licence agreement

This is a legal agreement between you, the end user, and PG Online Limited. This unit and all the worksheets, PowerPoint presentations, teaching guides and other associated files distributed with it is licensed, not sold, to you by PG Online Limited for use under the terms of the licence.

The materials distributed with this unit may be freely copied and used by members of a single institution on a single site only. You are not permitted to share in any way any of the materials or part of the materials with any third party, including users on another site or individuals who are members of a separate institution. You acknowledge that the materials must remain with you, the licencing institution, and no part of the materials may be transferred to another institution. You also agree not to procure, authorise, encourage, facilitate or enable any third party to reproduce these materials in whole or in part without the prior permission of PG Online Limited.